DOI: 10.22413/ijastems/2025/v11/i1/4

Predictive Maintenance for Vehicles Using IoT

M. Vasavi[1], P. Dharani[2], R. Sumalatha[3], P. PavanKumar[4], Y. Praveen Kumar Reddy[5]*
[1,2,3,4]UG Students, Department of EEE,Chaitanya Bharathi Institute Of Technology, Proddatur
[5]Assistant professor, Department of EEE,Chaitanya Bharathi Institute Of Technology, Proddatur
**Corresponding Author email id: vasavimarthanapalli@gmail.com*

Abstract*—The Predictive Vehicle Maintenance Using IoT is to make vehicles safer and keep drivers healthy by tracking real-time critical vehicle parameters. An Ultrasonic sensor measures and confirms the vehicles maintain safe distances from each other and issues collision avoidance warnings. A MEMS sensor picks up vibrations, which can be a sign of upcoming accidents or any misplaced conditions in vehicles. The Alcohol sensor verifies if the driver is drunk and hence makes the road secure. Temperature sensors track the internal condition of the vehicle, GPS tracks the location of the vehicle, and GSM provides SMS notifications in extreme conditions. The NodeMCU provides remote monitoring and control through Wi-Fi. The system also includes a buzzer that notifies the driver in risky conditions. This combined IoT-based solution provides safer driving and faster responses in emergency situations. Remote operating and monitoring using Wi-Fi are facilitated through the NodeMCU. Driver alert through buzzer for dangerous situations is also facilitated through the system. This all-in-one IoT-based solution makes driving safer and faster in event of emergencies.

***Index Terms*—UltraSonic sensor, MEMS sensor, Alcohol sensor, Temperature sensor, GSM, GPS, NodeMCU, Buzzer.**

I. INTRODUCTION

Predictive Maintenance for Vehicles Using IoT is a revolutionary solution to improve the safety of vehicles and the health of drivers by taking advantage of real-time monitoring of critical parameters[2]. It includes an ultrasonic sensor to ensure safe distances and avoid collisions, a MEMS sensor to sense vibrations that indicate accidents or abnormal conditions, and an alcohol sensor to determine if the driver is sober or not[3]. Temperature sensors manage the internal climate of the vehicle, a GPS module manages location,[1] and an SMS module initiates SMS alarms in emergency conditions. NodeMCU powers the system and also allows remote management and control by Wi-Fi, as well as a buzzer for warning drivers in risky circumstances[2]. The whole system ensures secure driving and proper response in case of emergencies.

Embedded system implementation

An embedded system is a specialized computer system employed for performing dedicated tasks in electronic devices. An embedded system is integrated with hardware and software (firmware) to effectively process, control, and store data. Embedded systems are built from microprocessors or microcontrollers and consist of hardware elements including memory, input-output interfaces, and communication ports. Embedded systems find widespread usage in everyday application in household appliances, car control, telecommunication, and smart cards. Their ability to give precise, real-time feedback makes them extremely useful in automation, safety, and productivity in industry.

II. LITERATURE REVIEW

The paper discusses the development and design of sophisticated car security system using GSM technology. The GSM-based mobile communication system gives messages on alarm and remote control facility based on SMS protocol. SMS can easily be utilized to give information exchange between user and system. Whenever the car door is opened or on the occurrence of abnormal vibration of the vehicle, alarm sound and an alarm SMS to the owner's mobile number in real time are generated. It provides timely alert and makes a vehicle economically secure with an economical efficient system.

GSM and GPS Technology-based Vehicle Security System with Tracking Facility has been proposed to provide increased security for vehicles with real-time tracking of the stolen vehicle and to offer genuine proof during theft. The system incorporates a Global Positioning System (GPS) receiver module, a Global System for Mobile (GSM) module, and a microcontroller as its basic components. Apart from that, it also possesses a vibration sensor to sense any unauthorized movement of the vehicle and an alarm buzzer that is triggered once it senses the sensors. Utilization of GPS and GSM technology provides real-time positioning tracing and immediate alert, thus making it an effective vehicle theft protection system.

Title: Vehicle Security System Using GSM Technology

The paper presents the design and implementation of a new car security system based on GSM technology. The system, GSM-based mobile communication, offers alarm messages and remote control facility based on the Short Message Service (SMS) protocol. Information exchange between the user and the system is easily available through SMS. On car door opening or upon involuntary vehicle oscillation, alarm is triggered and SMS notification is automatically sent to the owner's mobile phone. The system employs the timely notification method and enhances the security of the vehicle using an economical system at minimal cost.

Microcontroller-Based Vehicle Security System with Tracking using GSM and GPS Technologies is intended to enhance the security of vehicles by tracking a hijacked car in real-time and producing genuine evidence at the time of theft.

The system consists of a Global Positioning System (GPS) receiver module, a Global System for Mobile (GSM) module, and a microcontroller as the main components[1]. Other than this, it also has a vibration sensor to detect any illegal movement of the vehicle and an alarm buzzer that

DOI: 10.22413/ijastems/2025/v11/i1/4

is activated in the process of sensing the sensors. The integration of GSM and GPS technology allows real-time tracking and real-time alert and hence makes this a successful attempt towards vehicle security against theft. GSM-Based Vehicle Security System Authors: Aditya Bobade, Aditi Joshi, Tejas Patil, GSM-based Vehicle Security System is a new approach towards enhancing vehicle security using GSM communication. The system can be provided with real-time alarm with remote control facility.

The system will detect any unauthorized entry or movement and produce an alert signal, which will be received by the owner of the vehicle on his/her mobile phone through Short Message Service (SMS). The system also contains movement sensors for detecting suspicious movement and also contains a microcontroller for its efficient processing. With GSM technology, the project offers efficient car protection, quick alertness, and convenience, thus offering an easy way of car protection.

EXISTING METHOD

The present vehicle parameter monitoring technology uses conventional onboard diagnostic systems (OBD) with minimal data, which are usually targeted for engine performance, fuel efficiency, and simple fault codes. These systems typically require manual acknowledgment or have only a single diagnostic tool, so monitoring in real time of safety parameters such as driver state and surroundings is not possible. Current safety features of vehicles, such as collision or alcohol detection, are independent, costly, and separate from an automated alert system. Additionally, standard systems do not have remote monitoring, which limits the ability to respond to emergencies or dangerous situations in real time. This applies to an IoT-based integrated solution that combines safety monitoring with real-time alerts for enhanced driver and vehicle control.

Disadvantages of Current System are
•Limited Availability of Data
•Manual and Limited Monitoring
•Driver and Environment Not Monitored.
•Sandalone Features
•Complexity and Cost

PROPOSED METHOD

Predictive Maintenance for Vehicles Using IoT, with IoT technology and sensors, offers improved vehicle safety and convenience to the driver. It also features an Ultrasonic sensor for collision avoidance, an MEMS sensor for detecting abnormal vibration, and an Alcohol sensor for detecting alcohol. Temperature sensors offer the best temperatures, and GPS and GSM modules are used to track real-time location and emergency alert. NodeMCU offers remote monitoring via Wi-Fi, and an alarm system offers immediate notification. The system offers real-time monitoring, collision avoidance, and improved emergency response, and thus it is appropriate for public transport, commercial fleets, and traffic control.

HARDWARE AND SOFTWARE REQUIREMENTS

SOFTWARE REQUIREMENTS

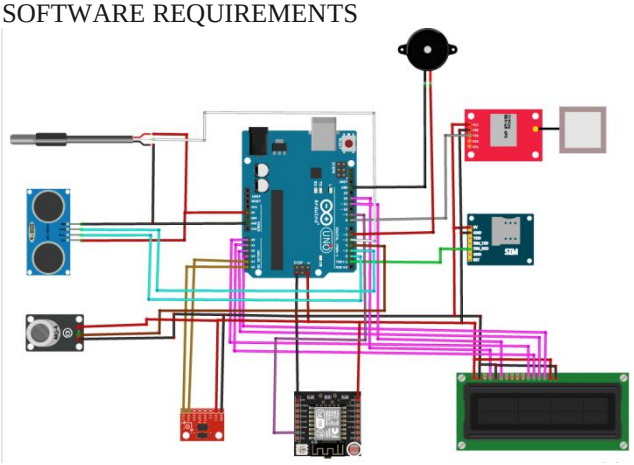

Fig1: Design of Block Diagram

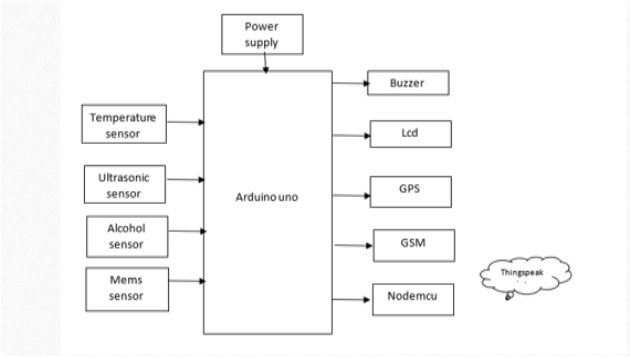

Fig 2: Block Diagram

Arduino IDE is open-source software used for coding, compiling, and programming the Arduino boards. It supports various Arduino modules and comes in Windows, Mac, and Linux versions. It possesses a text editor, compiler, and serial monitor for debugging purposes. C/C++ code can be written, built-in libraries can be utilized, and board and port choosing is easily accessible. It possesses a user-friendly interface that makes programming easy and accessible to both beginners and experts, enabling fast prototyping and project development.

HARDWARE REQUIREMENTS:

Arduino Uno is an open-source microcontroller board based on ATmega328P, which is used predominantly in embedded systems, robots, and Internet of Things. It supports up to 14 digital I/O pins, 6 analog input pins, USB connection, and serial communication through Tx and Rx pins. Programming is done using Arduino IDE, and the programming language can be coded in C and C++. Arduino Uno provides onboard voltage regulation, reset, and communication protocols like SPI, I2C, and PWM. Arduino Uno is very easy to use and very flexible. Ease of use, community involvement, and low cost make it the first choice of professionals and hobbyists.

DOI: 10.22413/ijastems/2025/v11/i1/4

MEMS Sensor

MEMS sensor is a tiny machine with electrical and mechanical components to sense and quantify external stimuli such as pressure, acceleration, and vibration. MEMS sensors are chip technology and are capacitive and piezo resistive types depending on the transduction mechanism. MEMS sensors find extensive application in industrial usage as they are accurate and cheap. A case in point is the MEMS 3-axis accelerometer, which senses motion in the x, y, and z axes and provides accurate angle detection and compensation in the majority of electronic products.

NodeMCU

NodeMCU is an open-source development board and firmware based on the ESP8266 Wi-Fi System on Chip for IoT applications. It supports different communication protocols like PWM, I2C, SPI, and UART, and thus can be used for different embedded projects. It supports power and programming through a MicroUSB port, USB to UART bridge, and onboard Wi-Fi. NodeMCU is programmed using Arduino IDE or Lua scripting, and thus it is easy to use and versatile. It is widely used in IoT home automation, security alarms, and wireless sensor networks due to its low cost, open-source nature, and onboard Wi-Fi.

MQ3 SENSOR

The MQ3 sensor is one of the most widely used MOS (Metal Oxide Semiconductor) alcohol sensors based on the resistance change mechanism when exposed to alcohol vapors. The sensor has an inbuilt heater and is covered with a stainless steel mesh of small particles to prevent explosions and eliminate unwanted particles. A Nickel-Chromium coil within heats the sensing element, and platinum wires transmit signal changes. Oxygen molecules of clean air create a high-resistance film on the SnO2 layer when exposed to clean air, limiting current flow. The sensor is used extensively in breath analyzers and alcohol sensors.

GPS

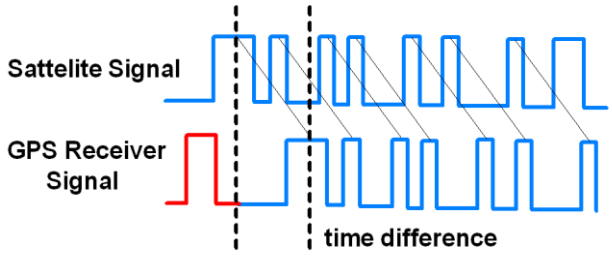

Fig 3:GPS Wave forms

The Global Positioning System (GPS) is a satellite navigation system that depends on satellite signals to calculate location, speed, and time with high precision. GPS receivers require information from a minimum of four satellites in order to deliver accurate location and utilize trilateration to calculate location. GPS operates by transmitting radio signals (1.1–1.5 GHz) from satellites, which the receiver calculates to find its distance from each satellite. GPS is used widely in smartphones, navigation, fleet tracking, and IoT. GPS modules deliver location information in NMEA format, which include longitude, latitude, altitude, and time, and are hence utilized for real-time tracking as well as navigation.

DS18B20 TEMPERATURE SENSOR

DS18B20 is a 1-wire digital temperature sensor that can send temperature data on a single data line. The sensor can be employed across the range of -55°C to +125°C with ±0.5°C accuracy and 9-bit to 12-bit resolution. Since the DS18B20 is powered by the data line itself, there is no requirement for any external power source. The sensor is employed extensively in industrial systems, consumer electronics, thermostatic controls, and temperature-sensitive products and is, therefore, best suited to be employed in applications where accurate and precise temperature measurement is needed in an environment.

LCD

LCD technology is also common in calculators, watches, and other handheld electronic devices because of its thinness, power savings, and capacity to show custom characters. An LCD is usually available in two forms: passive matrix (PM) and active matrix (AM). The active matrix, or TFT (Thin-Film Transistor) LCD, employs a transistor at each intersection of pixels, enabling faster response and reduced power consumption than passive matrix displays. The type 16x2 LCD display displaying 16 characters on a 2-line display is one popular module. There are two key registers, Command and Data, to drive the display and display content. LCD can be run in 4-bit or 8-bit mode where 8-bit mode is available for higher speed of transferring data at the expense of using more I/O pins on the microcontroller. In general, LCDs are inexpensive, simple to code and flexible to show alphanumeric characters and user-defined symbols.

GSM

GSM (Global System for Mobile Communication) is a digital cell technology used for mobile voice and data communication. GSM works over several frequency bands and employs Time Division Multiple Access (TDMA) to provide efficient sharing of the channels over several users. GSM networks include elements such as the Mobile Station (mobile phone), Base Station Subsystem (handles communication), and Network Subsystem (manages connectivity and routing). GSM provides several services such as SMS, voice calls, and good-quality speech, as well as security options like encryption. GSM modems based on SIM cards enable devices to talk over the GSM network and find very extensive applications in applications such as remote data logging and transaction systems.

DOI: 10.22413/ijastems/2025/v11/i1/4

BUZZER

A beeper or buzzer is a sound signaling device widely employed in electronic applications to produce sound alarms. It is mechanical, electromechanical, or piezoelectric in nature. Buzzer is utilized in alarm devices, clocks, user input acknowledgments (such as mouse clicks and keystrokes), and other devices like computers, printers, automobiles' electronics, and toys. The buzzer is normally powered with a 5V DC voltage and produces a steady beep under power. It has a small 2-pin configuration, so it is easy to place on breadboards, perf boards, and PCBs. Two forms are generally available: a basic buzzer that creates a steady tone and a ready-made buzzer with an on-board oscillator to provide a rhythmic beep. Buzzers are utilized in systems such as alarming circuits, communications gear, and mobile electronics, due to their miniaturized size and the fact that they are easy to incorporate.

PROJECT PHOTOS

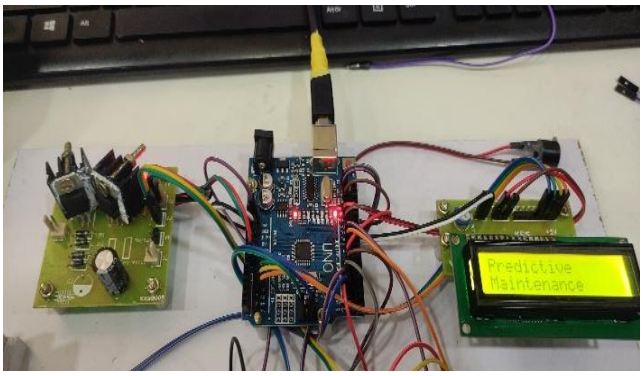

Fig 4: Power supply, Arduino & LCD

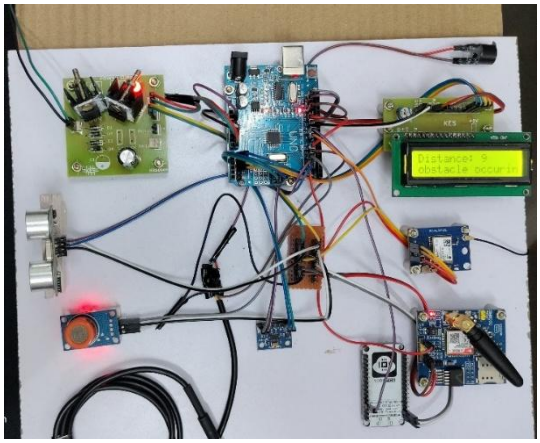

Fig 5:Overview of Predicitive Maintenance

TEST RESULTS

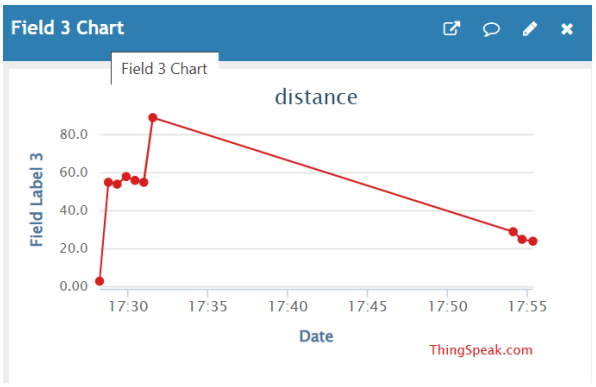

Fig 6: Graph Of Ultrasonic Sensor

CONCLUSION

The Predictive Maintenanace for Vehicles Using IoT and Intelligent Security System showcases the enormous power of IoT in revolutionizing vehicle management and security. Through smart sensor integration, RFID technology, and mobile app, the system provides a simple and effective solution to important vehicle parameter monitoring, security, and convenience. The aspect of being able to track fuel levels, engine oil, tire pressure, etc., from a remote distance as well as maintenance reminders and emergency sharing of locations alleviates some of the biggest car safety and maintenance concerns. It is not just the innovative solution which saves human labor but even the safety during journey and rescue at emergencies becomes streamlined, an enormity for designing intelligent and secure transport networks.

ACKNOWLEDGEMENT

We would like to thank our Guide Mr.Y.Praveen Kumar Reddy, Assistant Professor, andMr.N.Vara Prasad HODDepartment of EEE, Chaitanya Bharathi Institute Of Technology, Proddatur for supporting us to make this Publication.

REFERENCES

[1] ManaliShilimkar "Survey Paper on Vehicle Tracking System using GPS and Android", International Journal of Advanced Research in Computer Engineering & Technology (IJARCET) Volume 3 Issue 11, November 2014.

[2] Panem, C., Gad, V., & Gad, R. S. (2019). Polynomials in error detection and correction in data communication system. In Coding Theory. IntechOpen.

[3] A.Anusha "Vehicle Tracking and Monitoring System to Improve the Safety and Security Driving with IoT" 2017 International Conference on Recent Trends in Electrical, Electronics and Computing Technologies (ICRTEECT), July 2017.

[4] Panem, C., Gad, R. S., & Kaushik, B. K. (2021). Vertical traversal approach towards TSVs optimisation over multilayer network on chip (NoC). Microelectronics Journal, 116, 105231.

[5] Mayuresh Desai "Internet of Things based vehicle monitoring system" 2017 Fourteenth International Conference on Wireless and Optical Communications Networks (WOCN) IEEE, Feb 2017.

DOI: 10.22413/ijastems/2025/v11/i1/4

[6] Design and Implementation of Vehicle Tracking System Using GPS/GSM/GPRS Technology and Smartphone Application", IEEE World Forum on Internet of Things (WF-IOT), March 2014, Seoul.
[7] "Design and Development of GPS-GSM Based Tracking System with Google Map Based Monitoring", International Journal of Computer Science, Engineering and Applications VOL 3, No.3, June2013.
[8] Gundu, S. R., Panem, C. A., & Thimmapuram, A. (2020). The dynamic computational model and the new era of cloud computation using Microsoft Azure. SN Computer Science, 1(5), 264.
[9] AI-Driven Predictive Maintenance Systems Using IoT Sensors Jerry Cole.
[10] Predictive Maintenance Based On Machine Learning In Public Transportation Vehicles Özlem Güven, Hasan Fehmi Sahin 15 Apr 2022.
[11] Gundu, S. R., Panem, C. A., & Timmapuram, A. (2020). Robotic technology-based cloud computing for improved services. SN Computer Science, 1(4), 190.
[12] Predictive Vehicle Maintenance using Deep Neural Networks Neil Johnson, S. E. V. Ewards, D. Silas, Dr. G. Jaspher, W. Kathrine.
[13] Digital Twins for Automotive Predictive Maintenance E. Mohanraj, N Eniyavan, S Sidarth, Shankar Sridharan.
[14] Panchbhai, K. G., Lanjewar, M. G., Malik, V. V., & Charanarur, P. (2024). Small size CNN (CAS-CNN), and modified MobileNetV2 (CAS-MODMOBNET) to identify cashew nut and fruit diseases. Multimedia Tools and Applications, 1-21.
[15] 10.Sensor-Driven Predictive Vehicle Maintenance and Routing Problem with Time Windows Iman Kazemian, Bahar Çavdar, Murat Yildirim.
[16] Predictive Maintenance Based On Machine Learning In Public Transportation VehiclesÖzlem Güven, Hasan Fehmi Sahin 15 Apr 2022.
[17] Machine Learning Applications in Predictive Maintenance for Vehicles: Case Studies Ravi Aravind, Chirag Shah, Manogna Dolu Surabh.